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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/388,063	08/30/1999	VISHNU AGARWAL	MI22-1196	3351

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EXAMINER	
FENTY, JESSE A	

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 04/20/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/388,063	AGARWAL ET AL.	
	Examiner	Art Unit	
	Jesse A. Fenty	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *5-37* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *5-9, 11-15, 17-22, 24-37* is/are rejected.

7)☒ Claim(s) *10,16 and 23* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *3/16/4*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 5-9, 11-15, 17-22 and 24-37 are rejected under 35 U.S.C. 102(b) as being anticipated by Tsu et al. (U.S. Patent No. 5,635,741).

In re claim 5, Tsu (Fig. 2) discloses a semiconductor device, comprising:

First (18) and second (26) conductive electrodes having a high k capacitor dielectric region (24) positioned therebetween, the high k capacitor dielectric region comprising a layer of metal oxide (BST) having multiple different metals (Ba, Sr, Ti, erbium) bonded with oxygen, one of the metals when bonded with oxygen having a first current leakage potential (Ba, Sr, or erbium, another of the metals when bonded with oxygen having a second current leakage potential (the leakage potential of Ba, Sr, or erbium) which is greater than the first current leakage potential, the layer comprising at least one portion (layer 32 or 36) having a greater concentration of the one metal bonded with oxygen which is more proximate at least one of the first and second electrodes than another portion more proximate a center of the layer (column 6, lines 2-15). The outer layers (32 or 36), because they have a different Ba:Sr ratio than the layer (34), will inherently have one of the layers (Ba or Sr) having a higher concentration of the one

metal than the center layer (34). Ba and Sr also inherently have different current leakage potentials because they are different materials.

Additionally, the outer layers (32 and 36) are disclosed to have more erbium than the center layer (34).

In re claim 6, Tsu discloses the device of claim 5, wherein the another portion (the alternate side of the ratio) has a greater concentration of the another of the metals bonded with oxygen than the one portion.

In re claim 7, Tsu discloses the device of claim 5, wherein the layer comprises portions having a greater concentration of the one metal bonded with oxygen more proximate both the first and second electrodes than the another portion more proximate the center of the layer. Note that (column 6, lines 2-15), the Ba-Sr ratio may be different in layer (32/36) than in layer (34). Therefore, in the layers (32/36) closer to the electrodes, either one of Ba or Sr will have a higher concentration than in the layer (34).

In re claim 8, Tsu discloses the device of claim 5, wherein the at least one portion (32 or 36) contacts the one electrode.

In re claim 9, Tsu discloses the device of claim 5, wherein the layer comprises portions having a greater concentration of the one metal bonded with oxygen more proximate both the first and second electrodes than the another portion more proximate the center of the layer (as in claim 7), said greater concentration portion respectively contacting the first (18) and second (26) electrodes.

In re claim 11, Tsu discloses the device of claim 5, wherein the capacitor dielectric region consists essentially of the layer.

In re claim 12, Tsu (Fig. 2) discloses a semiconductor device, comprising:

First (18) and second (26) conductive electrodes having a high k capacitor dielectric region (24) positioned therebetween, the high k capacitor dielectric region comprising a layer of metal oxide (BST) having multiple different metals (Ba, Sr, Ti, erbium) bonded with oxygen, one of the metals when bonded with oxygen producing a first material having a first current leakage potential, absence of the one metal (erbium; column 6, lines 6-7) in the oxide creating a vacancy (a lessening of one of the elements) and a second material having a second current leakage potential which is greater than the first current leakage potential, the layer comprising at least one portion having a greater concentration of the first material which is more proximate at least one of the first and second electrodes than another portion more proximate a center of the layer. In the layers (32/36) closer to the electrodes, either one of Ba or Sr will have a higher concentration than in the layer (34).

In re claim 13, Tsu discloses the device of claim 12, wherein the layer comprises portions (32/36) having a greater concentration of the first material (erbium) more proximate both the first and second electrodes than the another portion (34) more proximate the center of the layer.

In re claim 14, Tsu discloses the device of claim 12, wherein the at least one portion (32/36) contacts the one electrode.

In re claim 15, Tsu discloses the device of claim 12, wherein the layer comprises portions having a greater concentration of the first material (erbium) more proximate both the first and second electrodes than the another portion more proximate a center of the layer, said greater concentration portions respectively contacting the first and second electrodes. If the erbium is doped into the layers (32/36), inherently some of the erbium will contact the given electrode.

In re claim 17, Tsu discloses the device of claim 12, wherein the capacitor dielectric region consists essentially of the layer.

In re claim 18, Tsu (Fig. 2) discloses a semiconductor device, comprising:

First (18) and second (26) conductive electrodes having a high k capacitor dielectric region (1) positioned therebetween, the high k capacitor dielectric region comprising a layer of metal oxide (BST) having multiple different metals (Ba, Sr, Ti, erbium) bonded with oxygen, one of the metals (Sr) when bonded with oxygen having a first dielectric constant, another of the metals (Ba) when bonded with oxygen having a second dielectric constant (column 6, lines 13-14) which is less than the first dielectric constant (of layer 34), the layer comprising at least one portion having a greater concentration of the one metal bonded with oxygen more proximate a center of the layer than another portion more proximate either of the first and second electrodes.

In re claim 19, Tsu discloses the device of claim 18, wherein the another portion (32/36) contacts one of the first and second electrodes.

In re claim 20, Tsu discloses the device of claim 18, wherein the another portion has a greater concentration of the another of the metals bonded with oxygen than the one portion.

In re claim 21, Tsu discloses the device of claim 18, wherein the layer comprise portions having a greater concentration of the another metal bonded with oxygen more proximate both the first and second electrodes than the one portion more proximate the center of the layer, said greater concentration portions respectively contacting the first and second electrodes.

In re claim 22, Tsu discloses the device of claim 18, wherein the capacitor dielectric region consists essentially of the layer.

In re claim 24, Tsu discloses the device of claim 18, wherein the metal oxide with multiple different metals bonded with oxygen comprises barium strontium titanate (BST), and the one metal comprises at least one of barium and strontium.

In re claim 25, Tsu (Fig. 2) discloses a semiconductor device, comprising:

First and second conductive electrodes having a high k capacitor dielectric region positioned therebetween, the high k capacitor dielectric region comprising a layer of metal oxide having multiple different metals bonded with oxygen, one of the metals when bonded with oxygen producing a first material (34) having a first dielectric constant, absence of the one metal (the variation of the Sr-Ba ratio) in the oxide creating a vacancy and a second material (32/36) having a second dielectric constant which is less than the first dielectric constant (column 6, lines 13-14), the layer comprising at least on portion having a greater concentration of the first material which is more proximate a center of the layer than another portion more proximate either of the first and second electrodes. Note that either Sr or Ba will be greater in the layer (34), which is more proximate the center when the Sr-Ba ratio is changed. Thus, the claim is anticipated.

In re claim 26, Tsu discloses the device of claim 25, wherein the layer comprises portions having a greater concentration of the first material more proximate both the first and second electrodes than the another portion more proximate a center of the layer.

In re claim 27, Tsu discloses the device of claim 25, wherein the another portion contacts the one electrode.

In re claim 28, Tsu discloses the device of claim 25, wherein the layer comprises portions having a grater concentration of the another material more proximate both the first and second

electrodes than the one portion more proximate a center of the layer (column 6, lines 4-14), said greater concentration portions respectively contacting the first and second electrodes.

In re claim 29, Tsu discloses the device of claim 25, wherein the capacitor dielectric region consists essentially of the layer.

In re claim 30, Tsu discloses the device of claim 25, wherein the metal oxide with multiple different metals bonded with oxygen comprises a titanate.

In re claim 31, Tsu discloses the device of claim 25, whereinteh metal oxide with multiple different metals bonded with oxygen comprises BST, and the one metal comprises at least one of barium and strontium.

In re claim 32, Tsu (Fig. 2) discloses a semiconductor device, comprising:

First (18) and second (266) conductive electrodes having a high k charge storage dielectric region (24) positioned therebetween, the high k charge storage dielectric region comprising a layer of metal oxide having multiple different metals (Ba, Sr, Ti) bonded with oxygen, the layer having varying stoichiometry across its thickness (column 6, lines 2-16)), the layer comprising an inner region (32), a middle region (34), and an outer region (36), the middle region having a different stoichiometry than both the inner and outer region (column 6, lines 9-12), wherein the electrodes comprise material of at least titanium nitride (column 6, lines 30-34).

In re claims 33-37, Tsu discloses the devices of claims 5,12, 18, 25 and 32, wherein the capacitor is formed over a substrate (12) and devoid of intermediate layers between one of the first and second electrodes and the substrate.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Arita et al. (U.S. Patent No. 6,236,076 B1) in view of Ueda et al. (as above).

In re claim 32, Arita (Fig. 9) discloses a semiconductor device, comprising:

First (30) and second (82) conductive electrodes having a high k charge storage dielectric region (170) positioned therebetween, the high k charge storage dielectric region comprising a layer of metal oxide having multiple different metals bonded with oxygen, the layer having varying stoichiometry across its thickness (column 14, lines 9-30), the layer comprising an inner region (174), a middle region (176), and an outer region (178), the middle region having a different stoichiometry than both the inner and outer region. Arita does not expressly disclose the lower electrode comprising titanium nitride. Ueda (column 5, lines 35-38) discloses a lower electrode comprising titanium nitride. It would have been obvious for one skilled in the art at the time of the invention to use a buffer layer of titanium nitride as disclosed by Ueda in the electrode structure of Arita for the purpose, for example, of creating a buffer region to better isolate device regions.

Response to Arguments

3. Applicant's arguments filed 03/16/04 have been fully considered but they are not persuasive.

a. The objection to the Drawings are withdrawn.

b. Applicant argues that the device of Tsu ('741) does not anticipate independent claims 5, 12, 18 or 25. The references to the erbium layer are made more explicit in the office action above and the remarks below to answer Applicant's questions about how said layer is interpreted in the body of the rejection.

i. In re claim 5, Tsu essentially discloses two high dielectric constant layers (32/36 and 34). Tsu discloses (column 6, lines 2-16) said layers comprising Ba, Sr, Ti, erbium and oxygen. The layer (34) has a given stoichiometric potential when bonded with little or no erbium dopant; and the layers (32/36) have a second stoichiometric potential, by varying the Ba-Sr ratio and also by increasing the erbium dopant by 2%. Therefore, the device of Tsu meets the claim because not only two, but three metals of the layer (34) when bonded with oxygen are varied in relation to the layers (32/36). Applicant asks for an affidavit to describe information only known to Examiner. Examiner asserts that two separate BST layers comprising different stoichiometric ratios will inherently have different current leakage potentials. Similarly, and as noted in the reference, BST layers with different erbium contents will have different current leakage potentials. By varying the Ba-Sr ratio of the layers (32/36), one of the elements (Ba or Sr) when bonded with oxygen will have a higher percentage than the layer (34), thus being

closer to one of the first and second electrodes than another portion more proximate a center of the layer.

ii. In re claims 12 and 25, the layer (34) towards the center has "little or no" [erbium] dopant. The layers (32/36) more proximate at least one of the first and second electrodes have a greater concentration of the first material, erbium (column 6, lines 10-12).

iii. In re claim 18, Tsu is relied on similarly to the elements of claim 5. Since Ba and Sr are different elements, they inherently will have different dielectric constants. The inverse relationship of the ratio of Ba to Sr in the two outer layers will place one of the metals when bonded with oxygen more proximate a center of the layer than another portion more proximate either of the first and second electrodes.

c. Applicant argues that the device of Arita/Ueda does not obviate independent claim 32.

iv. In re claim 32, Examiner inadvertently described the second electrode as comprising the element (816) instead of (82). The same rejection is maintained with the substitution of the one reference numeral for the other.

d. This action is re-sent as a Non-Final Rejection because the rejection of Tsu is written to include a number of claims not previously addressed by that reference.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jesse A. Fenty whose telephone number is 571-272-1729. The examiner can normally be reached on 5/4-9 1st Fri. Off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 571-272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jesse A. Fenty
Examiner
Art Unit 2815